

Chapter 3.1 SURFACE WATER MONITORING PROGRAMS

Ambient Water Quality Monitoring (AWQM)

From January 1996 to December 2000 DEQ staff collected samples at approximately 1680 ambient water quality stations for a total of 55,247 independent observations for variety of physical and chemical parameters. The number of independent observations for the more common field measurements were 47,401 for temperature, 41,335 for pH, 47,411 for dissolved oxygen, 41,041 for specific conductivity, and 4,010 for Secchi depth. 30.5% of the stations were sampled 5 times or less. 4.6% of the stations were sampled 6 to 10 times. 9.4% of the stations were sampled 11 to 20 times. 25.6% of the stations were sampled 21 to 30. 14.2% of the stations were sampled 31 to 60 times and 15.7% of the stations were sampled more than 60 times during the five year period.

The monitoring network includes ambient water quality and Chesapeake Bay tributary stations, as well as stations located specifically for special studies. Stations are located to gather information from industrial, urban, rural, and undeveloped areas of the state. These data are gathered near industrial and municipal discharges, nonpoint source areas, public water supplies, unaffected areas, and previously unassessed areas.

In this way, stream miles at risk from major pollution sources are well documented, as are those where pollution risk is suspected or unknown. Regional office personnel who are most familiar with local conditions and concerns determine station locations, parameters sampled and frequency.

The number of stations representing a particular type of stream segment, the types of samples collected, the parameters analyzed, and the sampling frequency all vary depending on site conditions and program emphasis. Types of matrices collected include water and sediment. All stations are monitored for conventional parameters, about one-third are monitored for toxics in the sediments, and a smaller number are monitored for toxics in the water column (primarily trace metals). Areas with potentially greater risk are sampled more frequently, with more types of samples being collected. As the risk decreases, the sampling frequency and the number of the types of samples collected decreases. Table 3.1-1 gives an outline of the parameters covered and frequency categories.

Each basin summary, found in Chapter 3.4 this report, lists the ambient water quality monitoring (AWQM) and biological (benthic) monitoring summary data within the basin. In some basins, STORET data produced from USGS monitoring operations are included in order to provide better assessment of water quality. Summaries of the sampling data collected at each station during the reporting period are provided in Appendix B of this report.

Data Management

The data are managed through the Comprehensive Environmental Data System Water Quality Monitoring module (CEDS WQM), an in-house Oracle database application. The process begins with the entry of field parameters by field technicians followed by the electronic data transfer of the field data and requested services to the Division of Consolidated Laboratory Services (DCLS). Analyte data are reported back to DEQ from DCLS and screened for QA/QC problems. Restricted DEQ personnel may correct, delete or erase erroneously stored data. Ambient water quality monitoring data are available on the DEQ website at: <http://www.deq.state.va.us:4100/webapp/wqm.homepage>. Data can be provided to persons without such access in hard copy and digital formats by contacting the CEDS WQM coordinator at (804) 698-4449, restewart@deq.state.va.us

Table 3.1-1 Ambient Monitoring Program sample types, analyses conducted, and frequency of analyses

Water		Sediment	
Parameters:			
DO		Metals	
Temperature		Pesticides	
pH		Organics	
Bacteria			
Solids			
Nutrients			
Conductivity			
Salinity			
Secchi			
Alkalinity			
Acidity			
Total Solids			
Suspended Solids			
Dissolved Solids			
Silica			
Sulfide			
Color			
Tannin & Lignin			
BOD			
COD			
TOC			
Hardness			
Chloride			
Fluoride			
Metals			
Pesticides			
Organics			
Chlorophyll			
Algae			
Sampling Frequency:			
Annual		Annual	
Semiannual		Semiannual	
Quarterly		Quarterly	
Monthly			

Hydrologic Data Gathering

The Department of Environmental Quality (DEQ) and the U.S. Geological Survey (USGS) are the primary agencies responsible for collecting hydrologic data in Virginia. The two agencies have worked cooperatively since 1925 except for a brief period from 1957 to 1967 when the two agencies dissolved the cooperative effort and operated independently. Virginia is one of four States in the Union with such a cooperative agreement with the USGS. Individually, the agencies carry out their own agendas in the collection of hydrologic data. Together, they provide a comprehensive picture of the state of hydrologic affairs in the Commonwealth.

Hydrologic data collection in Virginia began over a century ago. The oldest active stream gaging station in Virginia is on the James River at Cartersville where hydrologic data was first collected in October 1898. Since then, the number of continuous record hydrologic gaging stations in Virginia has grown reaching a peak in 1981 with 211 continuous recording gaging stations in operation. However, by 2000, funding cuts and manpower reductions have reduced the number of active, continuous-record gaging stations in Virginia to 157.

Of Virginia's 157 active gaging stations, DEQ operates 67 and the USGS operates 90. Additionally, DEQ conducts instantaneous stream flow measurements at more than 80 sites while the USGS conducts such measurements at over 100 sites. The DEQ instantaneous measurement sites are typically located upstream of the Virginia Pollutant Discharge Elimination System (VPDES) permit discharges while the continuous record gages are located primarily on larger, free flowing streams. The USGS also operates 9 gages on lakes and reservoirs that provide stage and contents data. Flow data, lake level data and other miscellaneous measurement data are published in Volume 1 of the annual report entitled "Water Resources Data Virginia", cooperatively prepared by the DEQ and the USGS.

The hydrologic data collected by DEQ and the USGS provide an essential component in the assessment of water quality in the State. The impact a point or non-point source pollutant discharge has on water quality in a stream cannot be adequately assessed without reliable stream flow data. If the stream in question does not have a continuous record gage or miscellaneous measurement site on it, the flow may be estimated by other means. However, such estimates are not nearly as accurate as field measurements or continuous gage hydrologic data.

Fish Tissue and Sediment Monitoring Program

DEQ monitors concentrations of chemical contaminants, including heavy metals and organic pollutants, in fish and shellfish tissue in order to assess the human health risks for individuals who may consume fish from state waters. Additionally, sediment samples are also collected at each sample station and are analyzed for the same pollutants. The sediment data are used to help locate a source of pollution where the fish tissue data indicate a concern. The sediment data are also used to identify potentially impaired aquatic ecosystems.

In the fish tissue-monitoring program, a two tiered sample strategy is followed which is consistent with federal guidance for fish tissue contamination monitoring programs.

Tier I is a screening study of a relatively large number of sample stations to identify sites where concentrations of contaminants in the edible portions of fish indicate potential health risks to human consumers. Sediment samples are also collected to assess whether stream sediments are contaminated to a degree that poses a potential for aquatic ecosystem impairment. Tier I stations are selected using a rotational river basin approach of all the river basins in Virginia. Until 1996, approximately 25-30 stations were selected among two river basins each year as the routine monitoring. The Code of Virginia § 62.1-44.19.5 requires maintenance of the 1996 level of tissue and sediment sampling which equates to a minimum of 24 fish sample stations per year. Since 1996 the following number of stations have been sampled for fish and sediment; 1997, 43 stations, 1998, 54 stations, 1999, 58 stations, 2000, 72 stations, with a variable number of some additional stations sampled for sediment each year.

Several criteria are used to select the sample stations and include correspondence with the DEQ-Waste Division to identify contaminated waste sites that may impact tissue and sediments in aquatic

environments. These are regional office recommendations, extensive literature searches, important recreational and/or commercial fisheries (Department of Game and Inland Fisheries, 1996), close proximity to point source discharges, and coverage of the entire watershed, i.e. headwater as well as higher order streams. Routinely, a minimum of three species of fish (top level predator such as a largemouth bass, mid-level predator such as a bluegill, and a bottom feeder such as catfish) are collected at each station. Edible filets from five to ten adult specimens of each species are composited into one sample, resulting in a minimum of three tissue samples per station. Depending on availability of additional funds and variability of species available, four or five species may be sampled at some stations.

Tier I analytical results for fish tissue are expressed in wet-weight and are compared to contaminant screening values that are computed using EPA risk assessment techniques for noncarcinogen and carcinogen effects. The screening values are calculated based on the same toxicity values and assumptions for average fish consumption rate, body weight and an acceptable extra cancer risk of 10^{-5} that were used in calculating the Virginia water quality criteria designed for the protection of human health from consumption of contaminated fish. These screening values represent the fish tissue concentration that the water quality criteria are intended to protect against. Occasionally, additional pollutants are sometimes detected in fish tissue for which Virginia does not have water quality criteria; or the toxicological information on the chemical has been revised and the water quality criterion has not been updated yet. In this case, an updated screening value is calculated and used to assess the data.

Analytical results for contaminants in sediments are expressed in dry-weight and are compared to effects range-median screening values provided by the National Oceanic and Atmospheric Administration to assess the potential effects of sediment contamination to aquatic life.

For additional information and data from previous years of sampling visit the DEQ website at <http://www.deq.state.va.us/rivers/fishsed.html>.

If tier I results indicate problems may exist, then a second more intensive tier II study is initiated to determine the magnitude and geographical extent along with potential source(s) of contamination in the fish and/or sediment.

The program fulfills the Clean Water Act § 106 United States Environmental Protection Agency (EPA) grant requirements for the collection of fish tissue and sediment. Data generated by the program are used by the Virginia Department of Health to determine the need for fish consumption advisories and/or bans. Data are also used by the DEQ and other state and federal agencies to assess the environmental quality of Virginia's waters. The following is a list of those compounds analyzed.

Metals:

Arsenic
Beryllium
Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc

Pesticides:

Aldrin	Endosulfan (alpha)
Dieldrin	Endosulfan (beta)
Endrin	Total PCBs
DDT	Toxaphene
DDE	Benzene hexachloride (alpha)
DDD	Benzene hexachloride (beta)
Chlordane	Lindane
Heptachlor	Benzene hexachloride (delta)
Heptachlor epoxide	Chlorpyrifos-methyl
Hexachlorobenzene	Mirex
Methoxychlor	Oxychlordane
Nonachlor	Pentachloroanisole
Dicofol	Polybrominated diphenyl ethers (BDEs)

Other Organics:

Acenaphthene	Diethylphthalate	Total PAHs
Acenaphthylene	Dimethylphthalate	Benzo (e) pyrene

Anthracene	Fluoranthene	Benzo (b) fluoranthene
1,2 Benzanthracene	Fluorene	Benzo (a) anthracene
Benzo (a) pyrene	Ideno (1,2,3-cd) pyrene	Benzo (g,h,i) perylene
3,4 Benzofluoranthene	Naphthalene	Benzo (l) fluoranthene
Benzo (k) fluoroanthene	4,6-Dinitro-2-methylphenol	
1,1,2, Benzoperylene	N-Nitrosodiphenylamine	
4-Bromophenyl phenylether	N-Nitroso-di-N-propylamine	
4 Chloro-3-methylphenol	Phenanthrene	
2-Chloronaphthalene	Bis (2-ethyl-hexyl) phthalate	
4-Chlorophenolphenylether	Butylbenzylphthalate	
Chrysene	Di-N-butylphthalate	
Dibenzo (a,h) anthracene	Di-N-octylphthalate	
3,3-Dichlorobenzidine	Pyrene	
2,4-Dimethylphenol	1,2,4-Trichlorobenzene	

Benthic Macroinvertebrate Monitoring Program

The Biological Monitoring Program (BMP) utilizes the study of bottom dwelling macroinvertebrate communities to determine overall water quality. Changes in water quality generally result in changes in the kinds and numbers of these animals that live in streams or other waterbodies.

The majority of the freshwater benthic macroinvertebrates found in Virginia come from four general groups: insects, mollusks, crustaceans, and annelid worms. Besides being the major intermediate constituent of the aquatic food chain, benthic macroinvertebrates are "living recorders" of past and present water quality conditions. This is due to their relative immobility and their variable resistance to the diverse contaminants that can be introduced into streams. No two groups of benthic organisms have the same limiting factor for the various chemical and physical constituents encountered in the aquatic ecosystem. The community structure of these organisms provides the basis for the biological analysis of water quality.

The BMP is composed of 150 to 170 stations that are examined annually during the spring and fall. Qualitative and semiquantitative biological monitoring has been conducted by the agency since the early 1970's. The US EPA Rapid Bioassessment Protocol (RBP) II was employed beginning in the fall of 1990 to utilize standardized and repeatable methodology. The RBP's produce water quality ratings of nonimpaired, slightly impaired, moderately impaired and severely impaired instead of the former ratings of good, fair and poor.

The procedure evaluates the macroinvertebrate community by comparing ambient monitoring "network" stations to "reference" sites. A reference site is one which has been determined to be representative of a natural, unimpaired waterbody. The RBP evaluation also accounts for the natural variation noted in streams in different ecoregions. One additional product of the RBP evaluation is a habitat assessment. This provides information on the comparability of each stream station to the reference site.

The results of data analyses and locations of stations are presented in Appendix B of this report. Like physical and chemical water quality monitoring data, biological monitoring data are used to assess water quality for support of aquatic life designated use.

Citizen Monitoring

Citizen monitoring has been a stewardship activity in Virginia for many years. As the amount of citizen-collected water quality data has increased, so has the interest in using these data for more than background information in Virginia's water quality assessments. In the past, citizen organizations established stream monitoring programs with limited support from the Commonwealth. A statewide organization, the Izaak Walton League of America Virginia Save Our Streams Program (IWLA VA SOS), took the lead in establishing relations with the Department of Environmental Quality (DEQ) and the Department of Conservation and Recreation (DCR) to develop a statewide citizen monitoring program. This was done through two separate letters of agreement signed by each agency in 1998 and was furthered by a three-way agreement signed in 1999. A new letter of agreement was signed in April 2002 to renew the

collaborative partnership and a new signatory, the Alliance for the Chesapeake Bay, was added to the partnership. Additional citizen monitoring information can be found on the DEQ website:
<http://deq.state.va.us/cmonitor>.

The positions of the Citizen Monitoring Coordinator within DEQ and the Community Watershed Stewardship Manager within DCR were created to provide guidance and technical support to citizen monitoring organizations. The Citizen Monitoring Coordinator is responsible for collecting citizen-generated data and formatting the data for agency use. This role has facilitated the use of citizen-collected data in Virginia's 305(b) Water Quality Assessment Report.

In addition, a budget amendment in the 1999 Virginia General Assembly Session created the Citizen Monitoring Grant Program to fund citizen monitoring activities. This grant program has provided funding to 47 different organizations over the past three years. The financial support from the Commonwealth has greatly enhanced the quality and quantity of citizen-collected data.

Currently, there are approximately 70 organizations throughout the Commonwealth with active citizen water quality monitoring programs. These programs vary in sophistication and in parameters monitored but all citizen-generated data are important in characterizing the state of Virginia's waters. Citizens monitor streams, lakes, and estuaries for a variety of parameters depending upon the goals of their program and the financial resources available. Common ambient measures include any of the following physical and chemical parameters: water temperature, pH, dissolved oxygen, nutrients (various forms of nitrogen and phosphorus), or solids suspended in the water column. Biological parameters measured by citizen monitors often include benthic macroinvertebrates, fecal coliform bacteria, and/or chlorophyll a.

While all citizen-collected water quality data throughout the state are important for this report, data collected under a DEQ-approved Quality Assurance Project Plan (QAPP) are considered more reliable and may be directly used in this report for the water quality assessment. A QAPP outlines the procedures a monitoring project will follow to ensure that the data collected meet project requirements. The DEQ Quality Assurance Officer reviewed QAPPs and supporting documents from citizen monitoring organizations submitting data. Citizen data collected under a DEQ-approved QAPP are used in the designated use attainability analysis and included in Appendix B of this report. Citizen-generated data collected without the benefit of a DEQ-approved QAPP or where the exact sampling location could not be confirmed were not directly used in this report. Data from citizen volunteers assist water quality agencies in prioritizing future monitoring and restoration work. Additional information associated with citizen monitoring assessment issues can be found in the 2002 Water Quality Assessment Guidance Manual found on the DEQ website
<http://deq.state.va.us/water/reports.html>.

In order to assist citizen monitoring organizations with developing and revising QAPPs, the Citizen Monitoring Coordinator and the Community Watershed Stewardship Manager are developing guidance materials for QAPP development specific to Virginia and will conduct sessions for citizen monitoring organizations. This additional level of assistance will increase the quality of citizen-collected data and make the task of QAPP development less burdensome for these organizations.

IWLA VA SOS has a benthic macroinvertebrate citizen monitoring protocol that is widely used by many affiliate organizations. In 2000, VA SOS completed a two-year study, funded by DEQ, evaluating this protocol and developing a new protocol to more closely correlate with professional methods developed by EPA and used by DEQ. Since IWLA VA SOS did not begin training its affiliate organizations in the new protocol until 2001, citizen data, using the new protocol, was not collected during the data window for this report.

The IWLA VA SOS protocol is suitable for monitoring higher gradient streams with riffles typical of those found in the western part of Virginia. In response to requests from citizens located in the eastern part of Virginia, IWLA VA SOS has established a committee to develop a protocol for low gradient, freshwater, nontidal streams. This committee is in the process of developing this protocol.

Cooperative partnerships have enhanced relationships between state agencies and citizen monitoring organizations which has improved the quality and quantity of citizen-collected data for this report.

This foundation is expected to continue and be built upon in the future.

DEQ would like to thank all of the organizations listed below for submitting citizen-collected data and supporting documentation for development of this report:

Alliance for the Chesapeake Bay
Audubon Naturalist Society
Clean Virginia Waterways
Culpeper Soil and Water Conservation District
Environmentally Concerned Citizens Organization (ECCO)
Friends of Claytor Lake
Friends of the North Fork of the Shenandoah River
Friends of the Shenandoah River
Hoffler Creek Wildlife Foundation
Izaak Walton League of America Virginia Save Our Streams Program
John Marshall Soil and Water Conservation District
Loudoun Soil and Water Conservation District
Loudoun Wildlife Conservancy
Mattaponi and Pamunkey Rivers Association
Maury River Alliance
North Fork Goose Creek Watershed Committee
Page County Water Quality Advisory Committee
Pedlar River Institute
Piedmont Region TMDL Initiative
Smith Mountain Lake Water Quality Monitoring Program (coordinated by Ferrum College and the Smith Mountain Lake Association)
Staunton-Augusta Chapter of the Izaak Walton League
Tidewater Resource Conservation and Development Council
Upper Levisa River Restoration Project

The IWLA VA SOS Program submitted benthic macroinvertebrate data collected by individuals and the following affiliate organizations:

Bluestone Watershed Committee
Buchanan Citizens Action Group
Buckingham Citizen Action League
Cowpasture River Preservation Association
Elliott Creek Watershed Protection Council
Environmentally Concerned Citizens Organization
Environmental Education Center
Friends of the North Fork of the Shenandoah River
Friends of the North River
Friends of Page Valley
Friends of the Rappahannock
Headwaters Association
J. R. Horsley Soil and Water Conservation District
Middle River Monitors
Northern Virginia Water Quality Monitoring Program (coordinated by the Northern Virginia Soil and Water Conservation District)
Pedlar River Institute
Piedmont Environmental Council
Rivanna Conservation Society
Rivanna River Basin Project
Skyline Chapter of Trout Unlimited
Upper Rappahannock Watershed Stream Monitoring Program
Virginia Museum of Natural History at Virginia Tech
Virginia Tech Student Chapter of the American Water Resources Association

Virginia Tech Wildlife Society
Walker Creek Watershed Group

In the river basin summaries, several terms are used in the citizen monitoring descriptions that are defined as follows:

- Ambient monitoring: Monitoring for physical and chemical water quality parameters
- Benthic macroinvertebrate monitoring: Careful observations of the macroinvertebrate (bottom-dwelling insects and crustaceans) community in a stream that can give an indication of long-term water quality conditions.
- Certified volunteers: IWLA VA SOS program volunteers that have gone through the training and testing process as identified in the IWLA VA SOS QAPP.
- VA SOS stream ratings: Four ratings - excellent, good, fair, and poor